

AUSTRALIA

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## PATENTS ACT 1990

## PATENT REQUEST: STANDARD PATENT

I/We, the Applicant(s) and Nominated Person(s) specified below, request I/We be granted a patent for the invention disclosed in the accompanying standard complete specification.

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## [54] Invention: Power Saver Home Automation System

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## ASSOCIATED PROVISIONAL APPLICATION DETAILS

[31] Application No(s)  
P03073

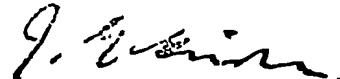
[33] Country  
AU

[32] Application Date  
19 June 1992

DATED this NINTH day of JUNE 1993

The Shortland County Council

By:



\_\_\_\_\_  
Registered Patent Attorney

OUR REF: 242254

S&F CODE: 13602

S 0383,2 : 80693



AU9341352

(12) PATENT ABSTRACT (11) Document No. AU-A-41352/93  
(19) AUSTRALIAN PATENT OFFICE

(54) Title  
**POWER SAVER HOME AUTOMATION SYSTEM**

International Patent Classification(s)

(51) G01R 011/56 G01R 011/57 G01R 011/58 G01R 022/00  
H02J 013/00 H04B 003/54

(21) Application No. : 41352/93

(22) Application Date : 18.06.93

(30) Priority Data

(31) Number (32) Date (33) Country  
PL3073 19.06.92 AU AUSTRALIA

(43) Publication Date : 23.12.93

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(57)

An electricity usage system (Fig. 1) is disclosed which incorporates a time-of-use meter (18), and at least one of an indicator (200), a piggy-back plug (210), a controlled outlet (220), and a controller (300) each of which embody the invention. The meter (18) includes a communications module (20) which permits identification of different tariff rates at different times. The embodiments (200,210,220,300) are configured to communicate over electrical conductors (22) of the system to identify which tariff is available. Preferably the embodiments (210,220) operate appliances and the like only when a particular tariff is available. The system permits a user the opportunity to minimize electricity costs.

Claim

1. Apparatus connectable to conductors of an electricity distribution system supplied via a time-of-use meter, said meter being configured to receive and/or transmit signals including the tariff rate of electricity supplied to said system, said apparatus comprising:  
communication means for communicating with said meter to

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Identify a presently available tariff rate; and  
indicator means for considering same and indicating to a user  
of said apparatus the presently available tariff.

23. An electricity usage system comprising:

a metering device for measuring quantities of energy consumed  
by said system, said metering device including a communications means  
adapted to receive and/or transmit signals including the tariff rates of  
electricity supplied to the system, and

one or more apparatus as claimed in any one of the preceding  
claims

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### POWER SAVER HOME AUTOMATION SYSTEM

The present invention relates to electricity supplies and, in particular, discloses an arrangement by which householders and smaller commercial concerns can cost effectively optimise the use of electricity.

5 It is common that the charging rate for electricity supply varies according to the level of demand. Electricity suppliers accordingly offer lower rates at times of low demand and it is therefore advantageous for electricity users to consume electricity during these periods, rather than others.

10 Typically, domestic off-peak hot water systems are adapted to be switched on by the electricity supplier when demand is reduced. However, the electricity user is unable to make use of such low rates for ordinary appliances as opposed to hard wired appliances like hot water systems.

Accordingly, it is desirable for electricity users to be able to  
15 select appropriate periods at which the cost of electricity supply is reduced.

In accordance with one aspect of the present invention there is disclosed apparatus connectable to conductors of an electricity distribution system supplied via a time-of-use meter, said meter being  
20 configured to receive and/or transmit signals including the tariff rate of electricity supplied to said system, said apparatus comprising:

communication means for communicating with said meter to identify a presently available tariff rate, and  
indicator means for indicating to a user of said apparatus the  
25 presently available tariff.

In accordance with another aspect of the present invention there is disclosed an electricity usage system comprising:

a metering device for measuring quantities of energy consumed by said system, said metering device including a communications means  
30 adapted to receive and/or transmit signals including the tariff rates of electricity supplied to the system; and

apparatus connectable to conductors supplied via said metering device and configured to communicate with said metering device so as to display to a user of said system the relative tariff of electricity  
35 supply.

Generally the indication can be a visual indicia provided by one or more lamps. Alternatively, a relay means adapted to supply an outlet of said system can be enabled when a particular tariff is available.

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In one preferred form, the apparatus is in the form of a controller which permits the programming of one or more other similar apparatus to enable selective operation when a particular tariff is available, or according to other user selected criteria such as the time and day of week.

A number of embodiments of the present invention will now be described with reference to the drawings in which:

Fig. 1 is a schematic block diagram representation of a household incorporating a system including a number of embodiments of the present invention;

Fig. 2 is a schematic block diagram representation of the system controller of Fig. 1 and being one embodiment;

Fig. 3 is a schematic block diagram representation of the indicator unit shown in Fig. 1 of another embodiment;

Fig. 4 is a schematic block diagram representation of the piggy-back unit shown in Fig. 1 of another embodiment;

Fig. 5 is a schematic diagram of a controlled outlet shown in Fig. 1 of another embodiment; and

Fig. 6 is a circuit diagram of a power supply unit used in the embodiments of Figs. 3, 4 and 5.

Referring to Fig. 1, the electrical wiring connections of a household 10 are shown in which a mains supply 14 comprising active (A) and neutral (N) lines is received from a mains distributor at a meter box 12 associated with the household 10. In some jurisdictions, an earth connection 16 is provided at the meter box 12 which permits an earth connection to be distributed throughout the household 10.

Included within the meter box 12 is a "time-of-use meter" 18 which allows for the metering of electrical power consumed within the household 10. The meter 18 is known in the art and is adapted to indicate the electricity tariff at any particular time, as well as other relevant information stored in a memory integral therewith. So as to implement this function, the meter 18 includes a communications module 20 which permits the reception of control signals received over the mains supply 14 as well as permitting communications with controlling devices within the household 10, as will be described.

Extending from the meter box 12 within the household 10 is internal cabling 22 including active (A), neutral (N) and earth (E) conductors.

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Shown connected to the cabling 22 are four general purpose outlets (GPO's) 24, 26, 28 and 30. These outlets are known in the art and permit interconnection of electrical appliances and the like to enable normal use of electricity.

5 Connectable to the GPO 28 is an indicator unit 200 which acts as a tariff rate indicator. The unit 200 includes three indicator lights 204, 205 and 206 which illuminate in turn depending upon a particular tariff of electricity supply being provided at any particular time. In this manner, the indicator unit 200 is able to communicate with the  
10 communications module 20 to detect changes in the tariff rate of supply and so indicate to the householder the actual tariff rate being charged at any particular time. The householder can then optimise usage of electricity so as to minimise the total cost of supply. Communications within the household 10 is achieved by means of the internal cabling 22  
15 directly.

Connectable to the GPO 30 is a piggy-back unit 210 which includes an outlet 218 complementing the operation of the GPO 30. The piggy-back unit operates in a manner similar to the indicator unit 200 but is able to be programmed so as to enable the outlet 218 only during specific  
20 periods when a particular tariff rate is available. An appliance 36, such as a domestic clothes dryer for example, can be plugged into the piggy-back unit 210 and turned on. When a pre-programmed rate of supply is available to the piggy-back unit 210, the outlet 218 is enabled which commences operation of the appliance 36.

25 Whilst the indicator unit 200 and the piggy-back unit 210 connect directly to general purpose outlets 28 and 30 respectively, the supply system includes a controlled outlet 220 which is connectable directly to the internal cabling 22. As seen in Fig. 1, a controlled outlet 220(A) is configured to supply energy to an appliance 34 via an integral outlet 218. The controlled outlet 220(A) is configured as a controlled general purpose outlet and includes a switch 224 enabling operation. The controlled outlet 218 may be manually controlled by utilising the ON or OFF positions of the switch 224. When the switch 224 is set in the AUTO position, the controlled outlet 218 is switched according to signals  
30 received from the controller 300.  
35

In an alternative configuration, the controlled outlet can be configured as a permanently connected circuit such as that shown by the

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controlled outlet 220(B) wherein a light or appliance (such as an air conditioner) 38 is connected to the terminals 219. A switch 226 can be made available to the householder for enabling of the light or appliance 38 when desired. In addition, the controlled outlet 220(B) operates in a 5 manner similar to the controlled outlet 220(A).

Also seen in Fig. 1 is a central controller 300 which is connectable to the GPO 24 and includes an RF connection 344 to a television set 32 connectable to a GPO 26. The controller 300 is adapted to communicate with each of the time-of-use meter 18, indicator unit 200, 10 piggy-back unit 210, controlled outlet 220(A) and controlled outlet 220(B), so that each of the switching devices can be programmed separately to enable operation according to the prevailing tariff rate or other criteria such as the time and day of week.

The controller 300 is adapted to be programmed using a hand held 15 remote control unit 350 and via the display of the television set 32. The programming of the controller 300 is adapted to provide the various facilities available within the system which include:

20 appliance ON/OFF programming;  
appliance ON/OFF control;  
appliance status interrogation;  
calendar/diary; and  
display of electricity usage and cost to date during a billing period.

Turning now to Fig. 2, the controller 300 represents a general 25 purpose computer configured with additional components to operate in accordance with one embodiment. The controller 300 connects to the GPO 24 using an AC input 302 which connects the mains supply to an internal power supply 310 via a switch 304, fuse 306 and ripple control ballast 308. The power supply 310 outputs direct current supplies to 30 various components within the controller 300. Connectable to the AC input 302 is a controller powerline (P/L) communications interface module 312 which allows for the transmission and reception of control signals over the internal cabling 22 using a 120kHz carrier injected into the mains supply. The communications module 312 supplies transmit and 35 receive signals to a microprocessor unit 330 via an interconnection board 318.

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Also connected to the interconnection board 318 is an infra-red receiving device 314 which permits the reception of signals from the remote control unit 350. The remote control unit 350 includes a keypad 352 with which the householder can select various functions and transmit 5 same to the controller 300. When the IR receiver unit 314 receives a transmission from the remote control unit 350, this is transmitted to the MPU 330 via the interconnect board, and a transistor 317 enables a LED 316 indicating the reception of data from the remote control unit 350. The MPU 330 is preferably a '286 microprocessor unit which includes 10 standard ROM, RAM, real-time clock and other components. The MPU 330 also outputs to the interconnect board 318 to supply four light emitting diodes 319 (green), 320 (yellow), 321 (red) and 322 (green) indicating respectively low, middle and high electricity tariffs, as well as a message reception from an external source, such as a message sent by the 15 electricity utility (supplier) over the mains supply 14.

The MPU 330 connects via a bus 334 to a VGA graphics unit 336 which outputs vertical sync, horizontal sync, and red, green and blue pixel data information on a bus 338. This data is transmitted to a video modulator 340 which in this embodiment is configured for the PAL system. 20 The modulator 340 supplies an RF modulator 342 which supplies an RF output 344. The RF output 344 permits interconnection with a television receiver 32 so that the controller 300 can display various menus and electrical consumption statistics.

Application software within the controller 300 performs a number of 25 functions. Firstly, remote switching of the various appliances 34, 36 and 38 connected to the units 210 and 220 as well as interrogation of the ON/OFF status of those devices can be programmed. Programmed switching of those devices can be established using a daily or weekly time clock, or using a tariff window (i.e. where electrical supply is enabled 30 whenever a particular tariff is available). The controller 300 also performs calendar, clock and diary function and includes real-time display of electricity tariffs, rate of use, kilowatt usage and operation costs in dollars per hour. The controller 300 also permits interrogation of the time-of-use meter 18 to provide electricity billing details. 35 electricity usage history and other information.

In addition, the controller 300 permits various other functions to be performed, in particular to provide billing and usage details and

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history for gas, water and other services utilised within the household  
P/L

Turning now to Fig. 6, the power supply 100 used in the units 200, 210 and 220 is shown. The power supply 100 connects to the active and  
5 neutral lines of the internal cabling 22 and includes a high voltage capacitor 104 which acts as a reactive ballast component to provide an AC current source of several tens of millamps from the mains supply. The input of the power supply 100 also includes an over-voltage protection device 101 and current shunt and limiting resistors 102 and 103,  
10 respectively.

The current supplied from the capacitor 104 is rectified using a bridge rectifier 105 which provides a DC current source that is filtered by a bank of electrolytic capacitors 106. Two zener diodes 107 and 108 act as shunt regulators with the latter providing preferably a  
15 -12 volt supply. The zener diode 107 provides a +15 volt signal which also forms a +TX signal for communication about the system as well as supplying a voltage regulator 109 which outputs a +5 volt supply. A further regulator 110 supplies a RESET signal which is used by CPU devices 120 residing in the units 200, 210 and 220, to be described.

20 The power supply 100 also includes a current transformer 112 to which is connected a bank of frequency determining ripple capacitors 113 which enable communications transmission over the internal cabling 22 by applying pulses to a SIGNAL input.

Turning now to Fig. 5, the circuit diagram of a controlled outlet 25 220 is shown which includes a supply input 222, a power supply 100, a CPU 120 and a P/L modem 125, each of which being common to the other units 200 and 210. The power supply 100 interconnects to the P/L modem 125 thus permitting communications transmission and reception over the internal cabling 22 of the household 10. The P/L modem 125 connects to  
30 the CPU 120 for the processing of received data and for the transmission of message data. The CPU 120 is preferably a 6805 microprocessor device which includes on-board ROM and RAM. The CPU 120 includes multiple programs permitting multi-use operation, and so that this may be effected, two sets of switches 130 and 132 are provided. The  
35 switches 130 permit the entry of a house code into the CPU 120 so that all communications made within the household 10 are unique and can be differentiated from corresponding communications in adjacent households.

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The set of switches 132 provides a specific unit address within the household 10 to identify the particular unit being communicated with. Having four selection bits, this enables up to 16 units of each type (200,210,220) to be operated simultaneously within a single household. The CPU 120 also includes a crystal oscillator 121 in the usual manner. Accordingly, with the switches 130,132 appropriately preset, the user is able to programme the controller 300 to issue programming and control signals to the controlled outlet 220.

Also shown in Fig. 5, the CPU 120 includes an arrangement of identity bits 135 which identify the particular function of the actual unit. The table below indicates the various bit connections of the CPU120 required to enable specific function of each device.

		PB3	PB2	PB1	PB0
15	Controlled Outlet				
20	- Light Switch (220(B))	0	0	0	0
	- GPO (220(A))	0	1	0	0
	Piggy-back (210)	NC	NC	0	1
	Indicator (200)	NC	NC	1	0

25 Connected to one output (PB7) of the CPU 120 is a relay circuit 140 with which transistors 141 and 142 operate a relay 143 that permits interconnection between the input 222 and the output 228.

30 The controlled outlet 220 can be configured for either power point applications (as in the controller 220(A) in Fig. 1) or for light switch operations (as in the controller 220(B) in Fig. 1). For this, optional switches 224 and 226 are provided respectively for power point and light switch operations. Each of the switches includes an ON, AUTO and OFF position. The ON and OFF positions permits user control at the actual controlled outlet 220, whereas the the AUTO position permits automatic operation as programmed via the controller 300.

Turning now to Fig. 3, the arrangement of the indicator unit 200 is shown which includes a supply input 208 and power supply 100, a P/L modem 125, switches 130 and 132, and a CPU 120 arranged in identical manner to

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those devices in the controlled outlet 220 of Fig. 5. Also, the identity bits 135 are arranged in a different manner according to the above table. In this embodiment, the CPU 120 includes three outputs PC1, PC2, PC3 which supply driver transistors 202 that enable illumination of light emitting diodes 204, 205 and 206 respectively. The LED's 204, 205, 206 are arranged with colours green, yellow and red respectively indicating an inexpensive tariff, a moderate tariff and a premium tariff of charging for electricity supply. In this manner, the indicator unit 200 can continuously indicate to the householder the cost of electricity supplied at any particular time. When the local tariff is unknown, the indicator unit 200 sequentially flashes the three LED's 204-206 to indicate an unknown tariff. At any time the tariff changes, the appropriate LED 204-206 is flashed for a predetermined period (e.g. 5 minutes) so as to draw attention to the tariff change. Corresponding functions occur with the LED's 319-321 of the controller 300.

Turning now to Fig. 4, the arrangement of the piggy-back unit 210 is shown which includes an input 212 and a power supply 100, P/L modem 125, switches 130 and 132, CPU 120 and relay unit 140 common with the arrangement of Fig. 5. Again, the identity bits 135 will be different. The piggy-back unit 210 also includes a mode switch 214 and a timer switch 216 which permits various operations to be selected. The mode switch 214 is a four position switch enabling either OFF, LOW, MEDIUM or HIGH (ON) tariff of usage operation. The timer switch 216 permits up to twelve different time intervals (e.g. ON, 1/2 hour, 1 hour 1 1/2 hours, 2 hours, 2 1/2 hours, 3 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours) to be enabled. Whenever a particular tariff is supplied to the piggy-back unit 210, the output 218 is enabled for a predetermined period of time. In this manner, the unit 210 can be used for selective operation of watering systems, ventilation systems and the like. With the timer switch 216 in the ON position, no timer function is selected. The OFF and HIGH positions of the mode switch 214 turn the output 218 unconditional off and on respectively. The intermediate positions LOW and MED, switch the appliance 36 on if the present local tariff is less than or equal to the tariff selected by the switch 214. Also, a tariff change will turn the appliance 36 off or on accordingly. An unknown tariff is considered to be high for the purpose of switching.

If the timer switch 216 is set to a specific time, the appliance 36 is turned on for that specified period each day. If the tariff specified

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by the mode switch 214 is only available for a shorter period than that selected, the appliance 36 is only turned on for that period.

Also, commands can also be sent to the piggy-back unit 210 from the controller 300 to switch the load remotely.

- 5 It will be apparent from the foregoing that the disclosed arrangements permit the householder to effectively utilise electricity supplies at optimum rates depending on those appliances desired to be operated at any particular time. Also, the system permits the user to continually monitor billing periods and in that sense offers a
- 10 cross-checking ability with the electricity supplier thereby preventing overcharging and the like.

The foregoing describes only a number of embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention.

- 15 For example, the lamps of the indicator unit 200 can be incorporated into piggy-back outlet 210 or controlled outlet 220. Furthermore, the relay switchable outlet of the controlled outlet 220, can be incorporated into the controller 300.

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The claims defining the invention are as follows:

1. Apparatus connectable to conductors of an electricity distribution system supplied via a time-of-use meter, said meter being configured to receive and/or transmit signals including the tariff rate of electricity supplied to said system, said apparatus comprising:

communication means for communicating with said meter to identify a presently available tariff rate; and

indicator means for considering same and indicating to a user of said apparatus the presently available tariff.

2. Apparatus as claimed in claim 1 wherein said indicator means provides a visual indicia as to the current tariff.

3. Apparatus as claimed in claim 2, wherein said indicator means comprises a plurality of lamps, each for a respective tariff.

4. Apparatus as claimed in claim 3, wherein when a change in tariff rate is detected by said communication means, the lamp corresponding to the new tariff is configured to flash for a predetermined period after the change.

5. Apparatus as claimed in any one of the preceding claims, wherein said indicator means comprises a relay means adapted to supply an outlet of said system arranged in said apparatus when a particular tariff is available.

6. Apparatus as claimed in claim 5, further comprising a manual mode switch whereby a user can select supply of said outlet via said relay means, or supply of said outlet directly from said conductors bypassing any tariff related operation of said relay means.

7. Apparatus as claimed in claim 5 or 6, further comprising a timer means configured to enable said relay means for a preselected period of time once said particular tariff is available.

8. Apparatus as claimed in claim 7, wherein said timer means comprises a user operable time switch with which said period of time can be selected.

9. Apparatus as claimed in any one of the preceding claims, wherein said communication means comprises a power-line modem configured to send and receive communication signals via said conductors.

10. Apparatus as claimed in claim 9, further comprising: microprocessor means configured to control operation of said apparatus and to interface between said power-line modem and said indicator means; and

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power supply means for connecting to said conductors to interface said communication signals to said power-line modem, and being configured to supply electrical power required for the operation of each of said microprocessor means, said power-line modem, and said indicator means.

11. Apparatus as claimed in claim 10, further comprising a (first) bank of switches connected to said microprocessor, said switches being configurable to provide a preselected code identifying said apparatus, whereby said apparatus will only accept communication signals which incorporate said preselected code.

12. Apparatus as claimed in claim 10 or 11, further comprising a second bank of switches connected to said microprocessor, said second bank of switches being configurable to provide an identity code to uniquely identify said apparatus.

13. Apparatus as claimed in claim 10, 11 or 12, further comprising a plurality of identity inputs to said microprocessor whereby an operational function of said apparatus can be altered by altering the identity inputs.

14. Apparatus as claimed in any one of claims 9 to 13, when dependent on claim 8, wherein said time switch connects directly to a plurality of inputs of said microprocessor means, the latter being programmed for operation as a variable period timer.

15. Apparatus as claimed in any one of claims 9 to 13, when dependent on claim 6, wherein said manual mode switch connects to a plurality of inputs of said microprocessor means, the latter being programmed for operation of said relay means with or without tariff related control.

16. Apparatus as claimed in any one of the preceding claims, wherein said apparatus is configured to be insertable into a general purpose outlet of said electricity distribution system.

17. Apparatus as claimed in any one of claims 1 to 15, wherein said apparatus is configured as a component permanently fitted in said electricity distribution system.

18. Apparatus as claimed in claim 5 or any one of claims 6 to 17 when dependent on claim 5, wherein said outlet arranged in said apparatus is configured in a manner corresponding to a general purpose outlet of said electricity distribution system.

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19. Apparatus as claimed in claim 5 or any one of claims 6 to 18 when dependent on claim 5, wherein said outlet arranged in said apparatus supplies a lighting circuit or a permanently connected appliance.

20. Apparatus as claimed in claim 10 or any one of claims 11 to 19 when dependent on claim 10, wherein said apparatus is configured as a controller unit of one or more of said apparatus as claimed in any one of claims 12 to 19, said controller unit and said apparatus being arranged within the same said electricity distribution system, said controller unit further comprising input means by which a user of said apparatus can programme said controller unit to issue communication signals comprising said preselected code to at least one said apparatus identified by said identity code included in said communication signals, said communication signals acting to programme a user specified function of operation into said at least one apparatus.

21. Apparatus as claimed in claim 20, wherein said input means comprises a receiving device configured to receive control signals output from a remote control transmitter operated by a user.

22. Apparatus as claimed in claim 21, wherein said controller unit further comprises a video display driver for driving a video display by which said user can be presented with control menu's facilitating said programming.

23. An electricity usage system comprising:

a metering device for measuring quantities of energy consumed by said system, said metering device including a communications means adapted to receive and/or transmit signals including the tariff rates of electricity supplied to the system, and

one or more apparatus as claimed in any one of the preceding claims.

24. Apparatus substantially as described herein with reference to Fig. 2, or Figs. 3 and 6, or Figs. 4 and 6, or Figs. 5 and 6 of the drawings.

25. An electricity usage system substantially as described herein with reference to Figs. 1, and any one or more of Fig. 2, or Figs. 3 and 6, or Figs. 4 and 6, or Figs. 5 and 6 of the drawings.

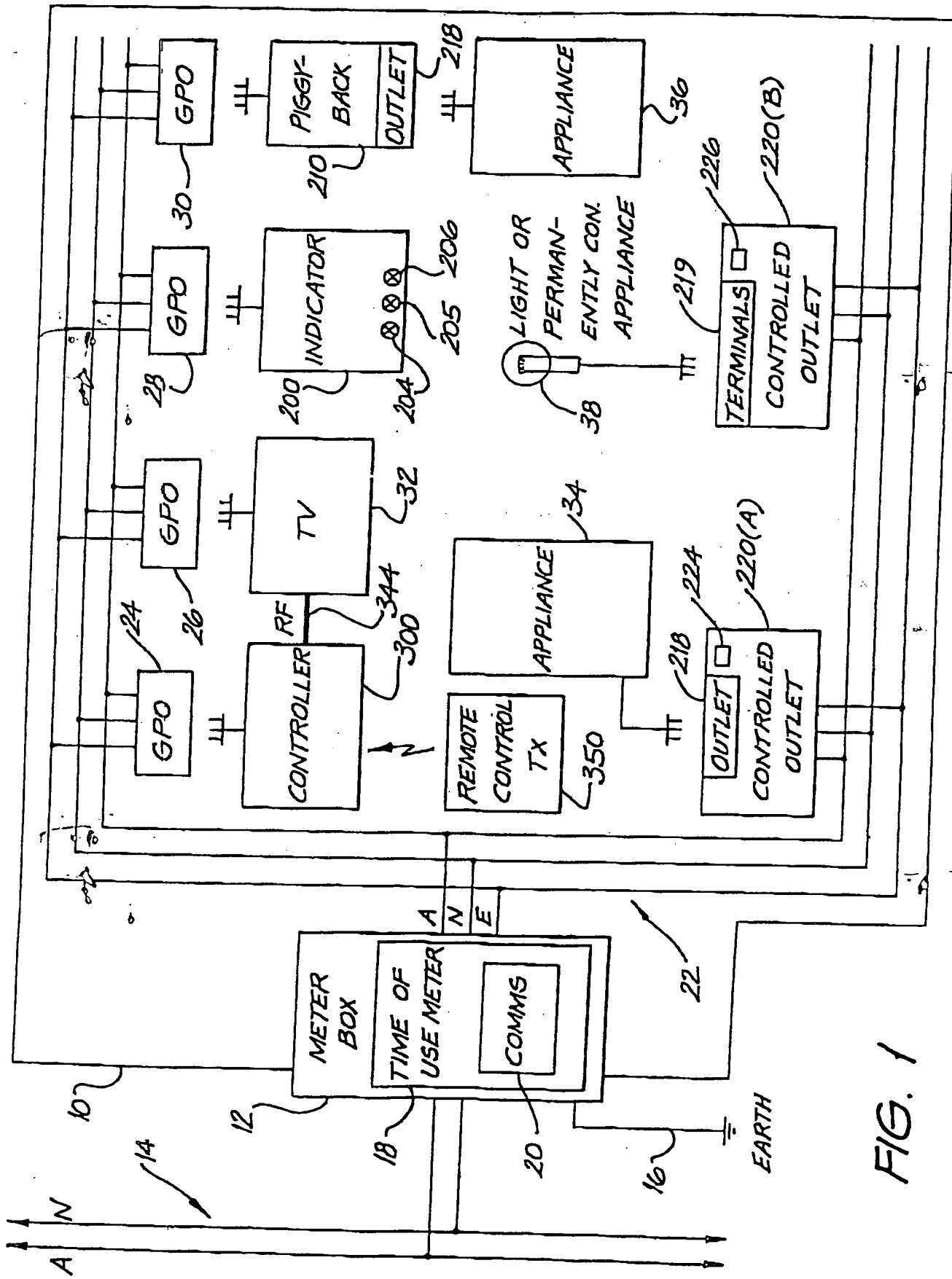
DATED this EIGHTEENTH day of JUNE 1993

The Shortland County Council

Patent Attorneys for the Applicant  
SPRUSON & FERGUSON

ABSTRACTPOWER SAVER HOME AUTOMATION SYSTEM

An electricity usage system (Fig. 1) is disclosed which incorporates a time-of-use meter (18), and at least one of an indicator 5 (~~200~~), a piggy-back plug (210), a controlled outlet (220), and a controller (300) each of which embody the invention. The meter (18) includes a communications module (20) which permits identification of different tariff rates at different times. The embodiments 10 (200,210,220,300) are configured to communicate over electrical conductors (22) of the system to identify which tariff is available.



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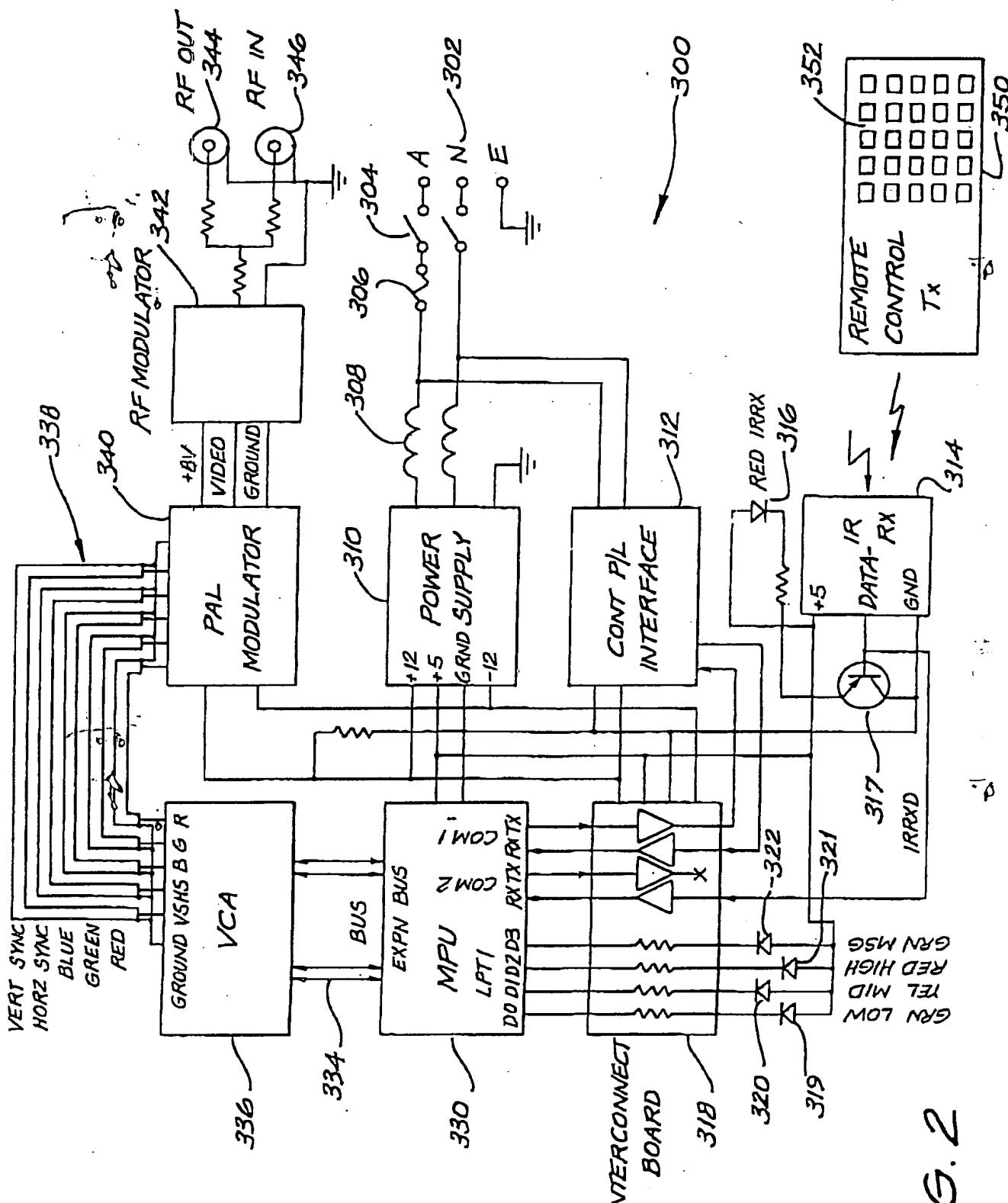


FIG. 2

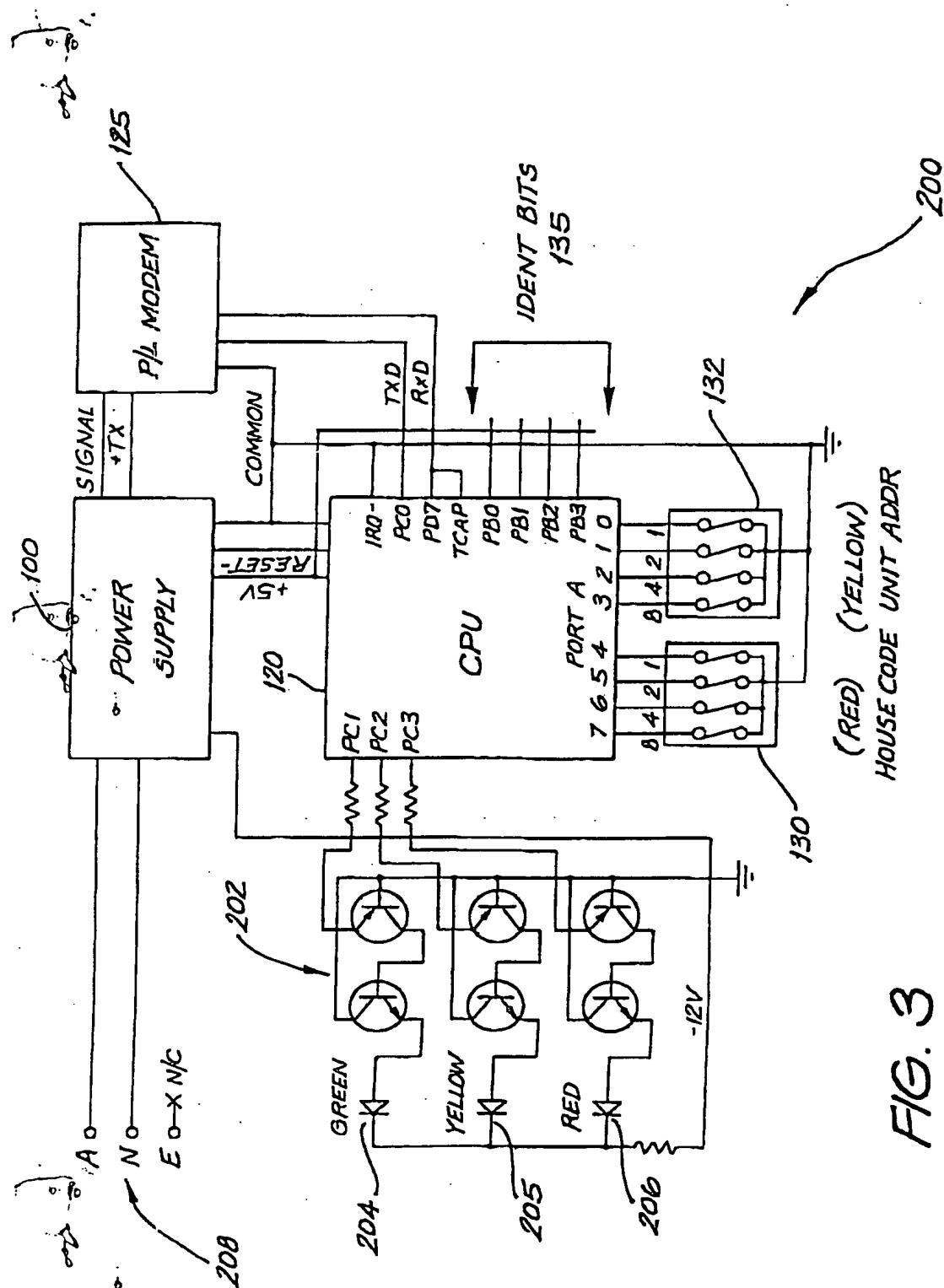


FIG. 3

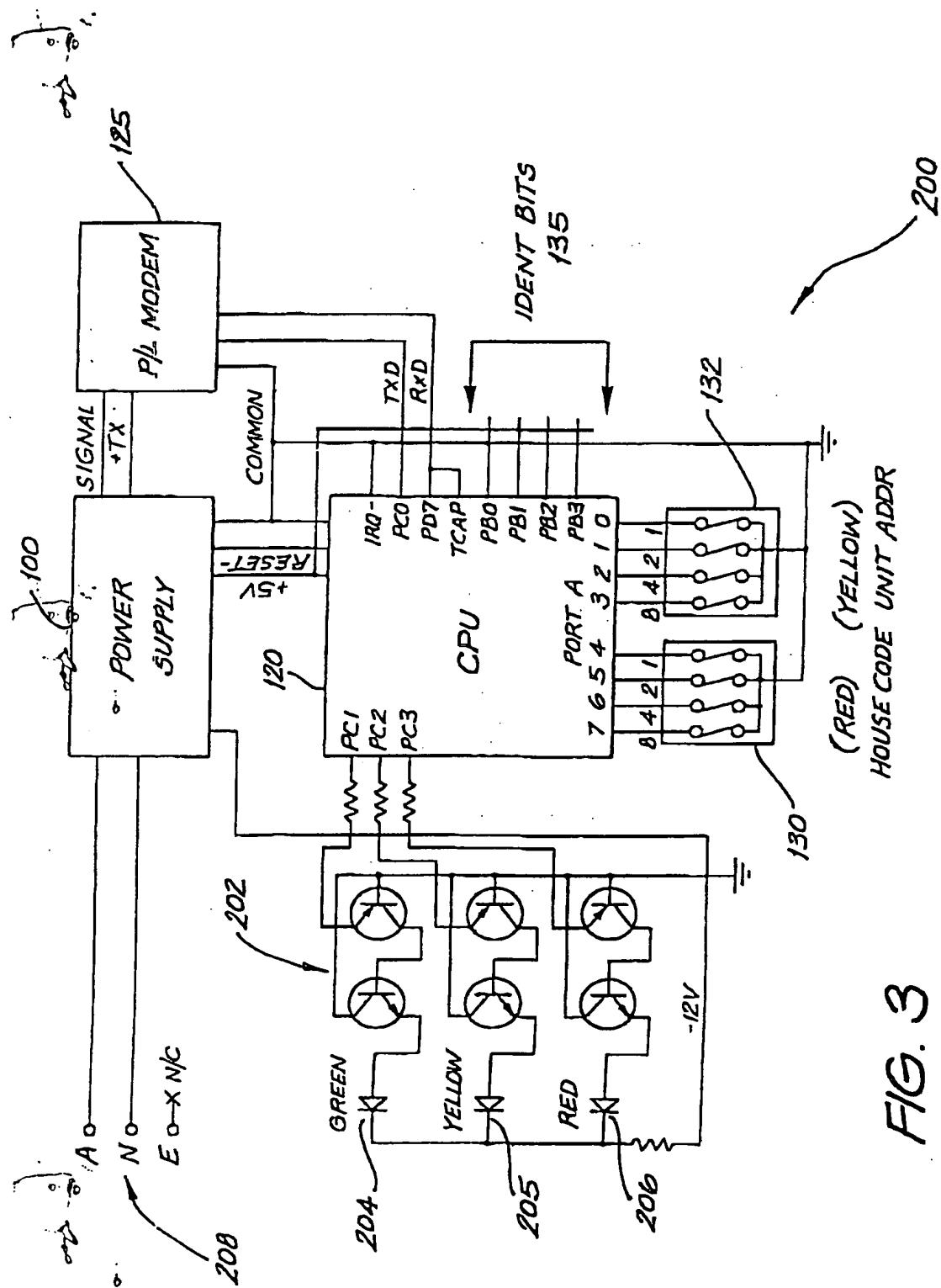
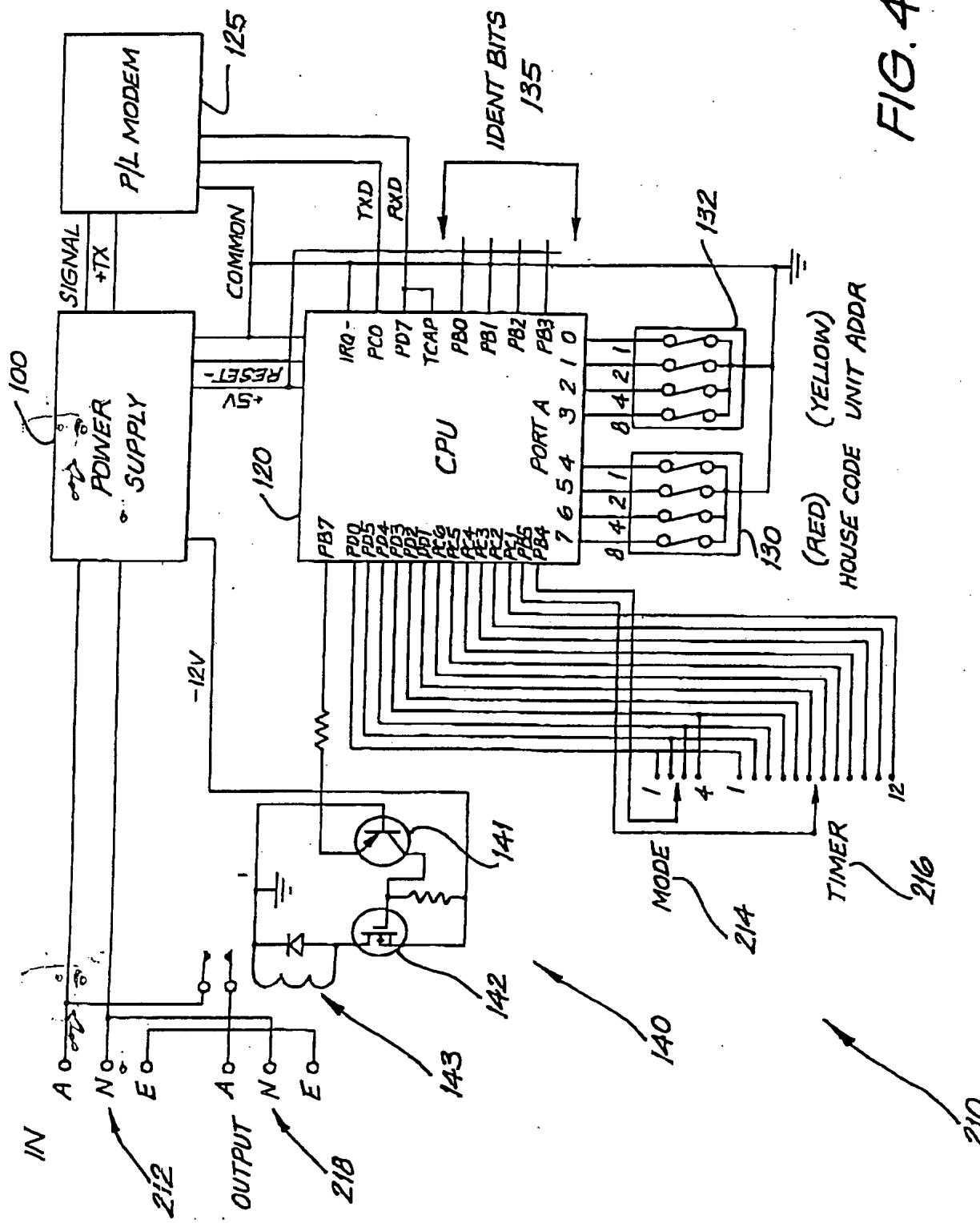


FIG. 3



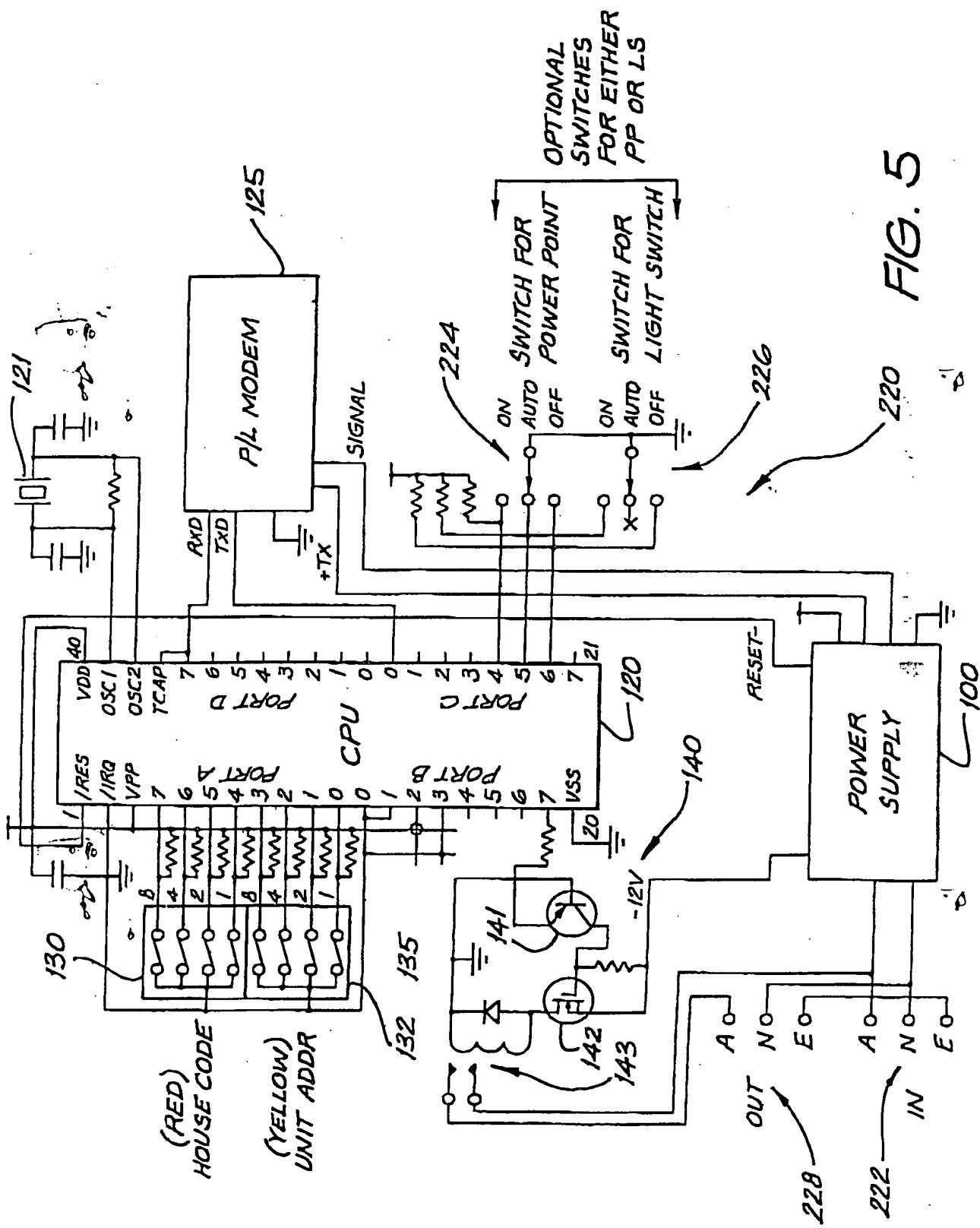


FIG. 5

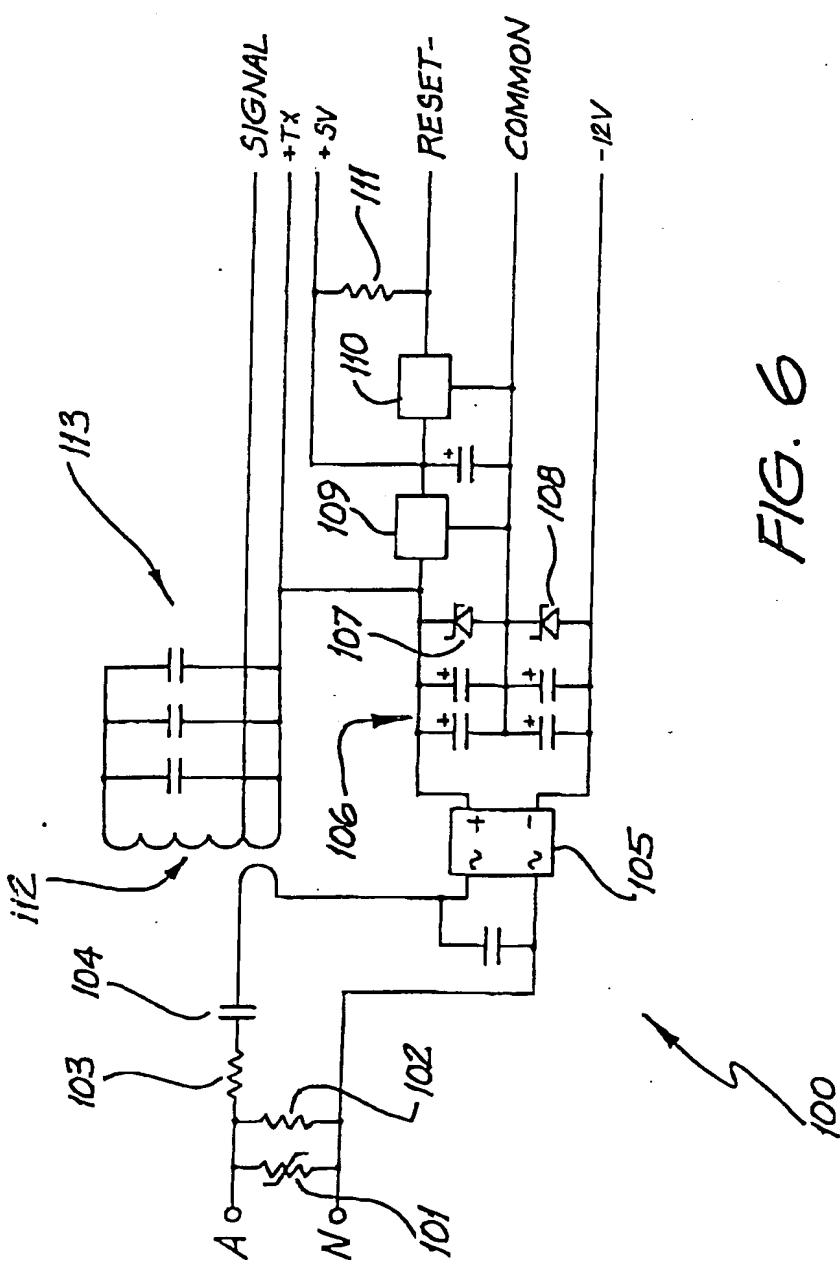


FIG. 6